Effluent Turbidity	<0.2 NTU
Effluent Trihalomethanes	<40 μg/l
Period of Nitrate Treatment	90 days (averaged over a 3 year period)

Alternative Treatment Schemes
The alternative treatment schemes evaluated included:

- Aquifer Storage and Recovery
- Biodenitrification
- Nanofiltration
- Side Channel Storage
- Groundwater Blending
- Ion Exchange
- Reverse Osmosis

Only the latter four were deemed to be feasible for the conditions at CIWC.

These four alternatives were preliminarily sized and designed. Projected water qualities, costs and operational considerations were discussed and evaluated.

Alternative Evaluations
Cost estimates were prepared for the alternatives including estimated capital and operational costs and a present worth analysis. The results are summarized below.

TABLE 1-1
COMPARISON OF ALTERNATIVES

TREATMENT ALTERNATIVE	CAPITAL COST ESTIMATE	OPERATION & MAINTANENCE COST ESTIMATE (1999)	PRESENT VALUE OF REVENUE REQUIREMENT ESTIMATE
Side Channel Storage	$12,936,290	$45,000	$21,604,304
Groundwater	$12,663,290	$25,000	$20,770,010
Ion Exchange – Co-Current	$6,297,290	$128,000	$11,529,291
Ion Exchange – Counter-Current	$6,379,790	$95,790	$11,315,352
Ion Exchange – Continuous Contactor	$7,894,790	$45,000	$13,033,923
Reverse Osmosis	$7,566,290	$434,000	$17,298,741

Recommendations
Based on the present value of revenue requirement costs developed in Chapter 8 and shown above, for the four treatment alternatives, CTE recommends the counter-current ion exchange alternative for treatment of the high nitrate occurrences. CTE also recommends that CIWC investigate the possibility of obtaining a new or modifying an existing NPDES permit to discharge the ion exchange waste to a receiving stream. This will reduce both the capital and operating costs, as the tables now reflect the cost to discharge the waste to the Sanitary District.

CHAPTER 2

PURPOSE AND SCOPE

The Consumers-Illinois Water Company, Vermilion County Division (CIWC) serves approximately 55,000 customers in Vermilion County, Illinois from its Danville, Illinois water treatment facility. CIWC is committed to providing its customers with high quality water, which meets all the applicable regulatory standards through the most cost-effective means. The purpose of this report is to investigate the available options for upgrading the quality of the finished water and to make recommendations as to the best long-term solution to current water quality challenges.

CIWC currently supplies treated surface water from Lake Vermilion. Lake Vermilion is an impoundment of the North Fork of the Vermilion River. It is fed by a drainage area of over 300 square miles. Much of this drainage area is under agricultural production. Lake Vermilion, therefore, exhibits many characteristics of similar supplies throughout the Midwest including impacts from agriculture, particularly before and during the planting season.

Lake Vermilion also exhibits relatively large, rapidly changing variations in turbidity due to its age, depth and configuration during certain weather conditions.

CIWC has invested a large amount of equity in both Lake Vermilion and the treatment plant. As such, this report will investigate methods available to continue to utilize these resources through further treatment or process modifications.

This report also will estimate future water usage and supply capacity, which must go hand in hand with any investigation of water quality.

CHAPTER 3

WATER USAGE AND PROJECTED WATER DEMANDS

The CIWC service area is located entirely within Vermilion County, and the majority of their current customers are within the City limits of Danville. Currently, the Water Company serves approximately 64 percent of the county's entire population of approximately 86,000, totaling approximately 55,000 persons.

Currently, CIWC is experiencing average day water demands of approximately 8.0 million gallons per day (mgd) and maximum day water demands of approximately 12.0 mgd. Records indicate that the population in the Danville area, as well as water demands have been decreasing in recent years and are projected to continue this trend to the turn of the century. A recent study for the Illinois Bureau of the Budget projects population figures for Vermilion County through the year 2020. These figures are shown in Table 3-1.

TABLE 3-1
VERMILION COUNTY POPULATION
AND
POPULATION PROJECTIONS

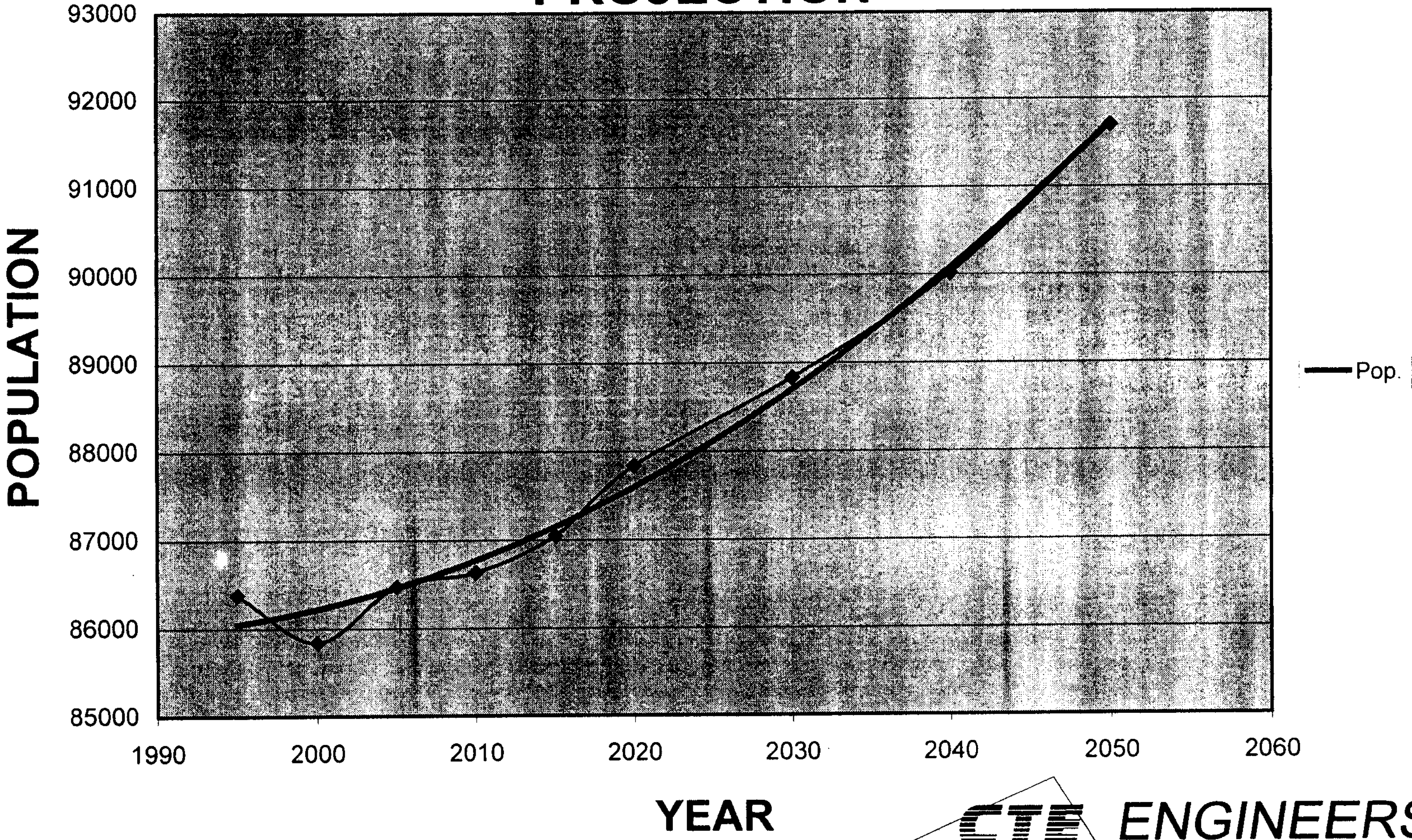
YEAR	POPULATION
1960	96,176
1970	97,047
1980	95,222
1990	88,257
2000*	85,840
2010*	86,634
2020*	87,836
2030**	88,834
2040**	90,014
2050**	91,703

* - **Indicates Projection by Illinois Bureau of the Budget**
** - **Indicates Linear Projection by CTE**

Using the historical figures provided and the projections of the Illinois Bureau of the Budget, Table 3-1 extends a linear projection of the Illinois Bureau of the Budget projections to the year 2050. Exhibit 3-1 is a graphical representation of this information.

Conversations with CIWC indicate their belief that growth within their current service area will be directly linked to the population of Danville and Vermilion County. Therefore, it is reasonable to assume that in the future, the demands of the current service area will grow proportionally to the demands of the county as a whole.

EXHIBIT 3-1
VERMILION COUNTY POPULATION PROJECTION



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Source: Illinois Bureau of the Budget

Project No. 44143

Historical information developed in conjunction with a Cost of Service Study prepared for CIWC by others indicates a daily water usage of approximately 145 gallons per capita per day and a maximum day to average day ratio of approximately 1.5. These figures are utilized along with the previously described population projections to develop water demand projections. Table 3-2 shows the average day and maximum day projections through the year 2050.

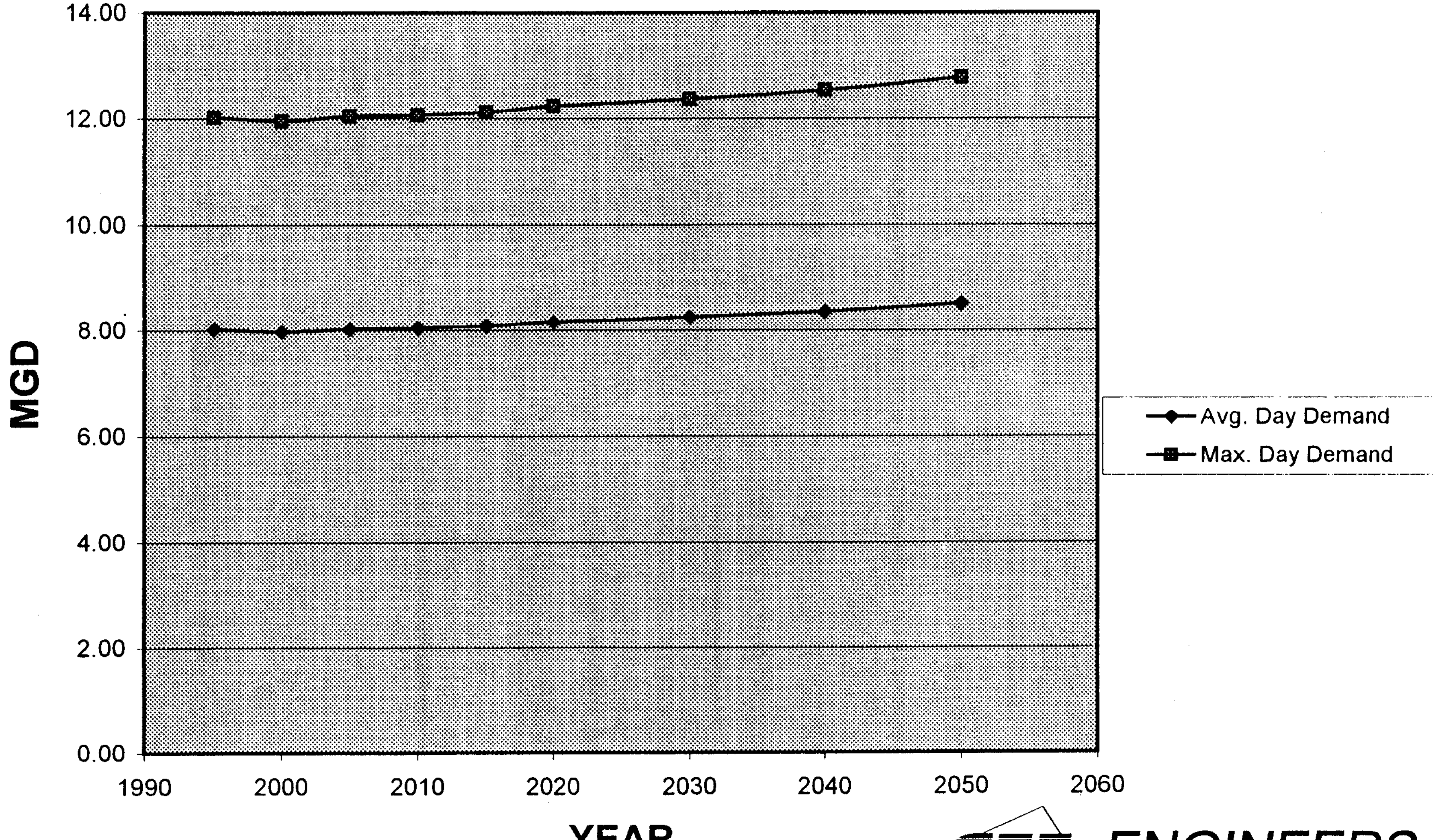
TABLE 3-2
AVERAGE AND MAXIMUM DAY WATER PROJECTION

YEAR	AVERAGE DAY (MGD)	MAXIMUM DAY (MGD)
1995	8.02	12.02
2000	7.97	11.95
2005	8.02	12.04
2010	8.04	12.06
2015	8.08	12.12
2020	8.15	12.23
2030	8.24	12.37
2040	8.35	12.53
2050	8.51	12.77

A graphical representation of the projected water demands is shown in Exhibit 3-2.

Exhibits 3-1 and 3-2 indicate that approximately a six percent growth is anticipated over the next fifty years or so. While this seems low, conversations with local business leaders indicate that this is not unexpected. The region has lost significant manufacturing employment since the early 1980's, and there are no known significant growth opportunities in the planning stages. Therefore, the rather low growth projections seem reasonable.

EXHIBIT 3-2
PROJECTED WATER DEMANDS



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CHAPTER 4

EXISTING WATER SOURCE

A. INTRODUCTION

As discussed previously in Chapter 2 of this report, CIWC currently utilizes Lake Vermilion as its sole water source. Lake Vermilion is an impoundment of the North Fork of the Vermilion River. The drainage area of the lake is over 300 square miles and primarily made up of land in use as agricultural production. The drainage area also includes urban and rural residential portions.

The lake was originally constructed in the 1920s and has been modified several times. Most recently, the overflow level of the spillway was raised five feet to increase the storage volume of the Lake.

The two critical parameters in describing the adequacy of any water source are quantity and quality. Without adequate levels of both, the surface water may not be viable as a drinking water source. Lake Vermilion is characterized with regard to these parameters in this chapter.

B. LAKE VERMILION SUSTAINABLE YIELD

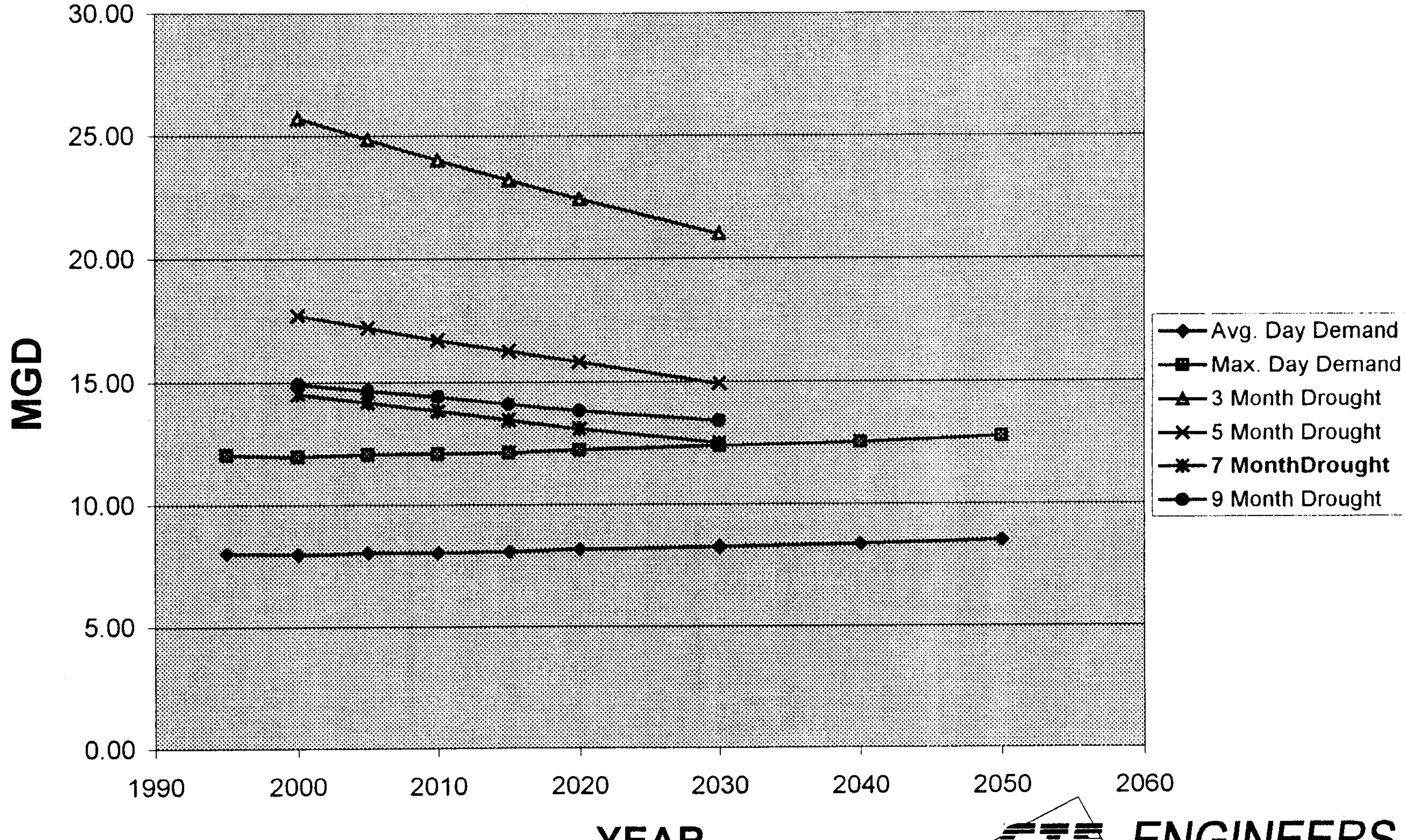
CIWC contracted with Illinois State Water Survey (ISWS) to complete a sustainable yield assessment of Lake Vermilion. The sustainable yield represents the rate at which water may be withdrawn on a long-term basis. The sustainable yield for any given reservoir is not constant over time.

In addition to this study, a sedimentation study has been performed for Lake Vermilion. The sedimentation survey draft, dated May, 1999, confirmed what the previous safe yield study indicated. Previous sedimentation studies have been done for the lake in 1963 and 1976 and the survey lines used in 1963 were repeated as closely as possible for the 1998 study to define the differences in the lakebed topography. The draft study report indicates that sedimentation has reduced the potential capacity of the lake from 13,209 acre-feet (ac-ft) in 1925 to 7971 ac-ft in 1998, which is 60.3 percent of the 1925 potential capacity. However, overall, the sedimentation rates are declining. The sedimentation rates were high in the initial study period from 1925 to 1963, but they are considerably lower for the period of 1963 to 1998. The sedimentation thickness ranges from 2.3 to 9.3 feet with the most significant accumulation north of Denmark Road and north beyond the old dam. Both the capacity loss rate of the lake (0.54 % per year) and the watershed sedimentation yield rate (0.40 ton/acre) of the lake are average values for Illinois impoundment lakes. Because it is essential to maintain adequate storage capacity in the lake for Danville's water supply, programs should be continued to control watershed erosion to reduce sedimentation rates.

Factors such as changing land use patterns in the drainage area; sedimentation of the reservoir; changes in discharge or withdrawals upstream of the lake; or the effects of any construction or dredging in the lake will affect the sustainable yield. The effects of these changes are likely to be gradual over the fifty year projection utilized in this report.

The sustainable yield for a reservoir also varies depending on the severity of the drought in question. In other words, the more severe the drought, the less water available for a water supply. Typically, in the Midwest, a fifty-year drought event is used as the design condition.

EXHIBIT 4-1
SUPPLY VS WATER DEMANDS



7 Month Drought is critical drought duration.

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The ISWS Safe Yield Study estimated the North Fork of the Vermilion River drought flows based on historical stream records upstream and downstream of the reservoir. The upstream gaging station located at Bismarck does not include the entire drainage basin for Lake Vermilion in its data. Therefore, it does not represent the total stream flow into the Lake. The downstream gaging station at Danville is located downstream of the confluence of the North Fork and the Vermilion River, so it too does not represent flow in the North Fork alone. Therefore, the data was manipulated in order to estimate the true flows to Lake Vermilion. Using the available data, ISWS utilized a budget method to account for the inflows and outflows for the river between the two gaging stations so that the actual flow could be estimated. Exhibit 4-1 illustrates the results of the calculations showing drought discharges in the North Fork of the Vermilion for various drought durations and over a return period of up to 50 years. As illustrated in Exhibit 4-1, the critical drought duration is seven months. For large drainage areas, such as Lake Vermilion, the critical duration is typically less than one year. This is due to the fact that the larger the drainage area and the longer the drought duration, the more likely it is to rain at some location within the drainage area.

The estimated future storage volume of the Lake can be calculated based on the drought stream flows, the reservoir volume, and the assumptions that the useful storage of the reservoir is 90% of its volume and that the reservoir is full at the beginning of the drought (which is consistent with CIWC policy to maintain the reservoir level at 0.5 feet below the top of the spillway). ISWS utilized various methods, based on similar sites in Illinois, to estimate both net evaporation and long-term sedimentation of the lake. The estimated future storage volume of Lake Vermilion estimated by ISWS is shown in Table 4-1.

TABLE 4-1
ESTIMATED FUTURE STORAGE VOLUME
(ACRE-FEET)

	Estimated Future Storage Volume (ac-ft)				
Pool Elevation	**1990**	**2000**	**2010**	**2020**	**2030**
583	9264	8693	8160	7675	7243
582.2	8369	7798	7265	6781	6348
581	7086	6515	5982	5497	5065
579	5166	4595	4062	3577	3145
578	4338	3767	3234	2750	2317
577.2	3785	3214	2681	2197	1764
576.7	3479	2908	2375	1890	1458
575.9	2865	2294	1761	1277	845
575.2	2375	1803	1270	786	354
574.2	1700	1129	596	111	0
573.6	1332	760	227	0	0
573.5	1270	699	166	0	0
573.0	964	392	0	0	0
572.7	718	147	0	0	0
572.2	503	0	0	0	0
571.7	258	0	0	0	0
570.2	0	0	0	0	0
568.2	0	0	0	0	0
563.2	0	0	0	0	0

Table 4-2 illustrates the yields estimated by ISWS. These figures indicate that for a 50 year drought, the yield will range from 25.7 to 21.0 mgd for a three month duration drought and from 14.9 to 13.4 mgd for a nine month duration drought. These values are calculated for a given return period and drought duration by adding the estimated North Fork Vermilion River drought flow to the estimated reservoir storage to generate a gross draft rate. The estimated net evaporation is then subtracted from this to generate an estimate of gross draft less net evaporation or available yield under the chosen conditions. Table 4-2 is generated in this manner and also presents the yields in units of million gallons per day.

TABLE 4-2
LAKE VERMILION MAXIMUM YIELDS CALCULATED USING RESERVOIR VOLUMES ESTIMATED FROM U.S. ARMY CORPS OF ENGINEERS DAM SAFETY REPORT VALUES

North Fork Vermilion River Drought Flows			
Duration	Return Period (years)		
Months	10	25	50
3	10.8	8.6	7
5	14	10	9
7	17.3	13.6	10
9	39	21.3	13

Net Evaporation (cfs)			
Duration	Return Period (years)		
Months	10	25	50
3	5.61	5.91	6.1
5	4.51	4.7	4.81
7	3.29	3.68	3.86
9	2.44	2.66	2.79

Duration	Reservoir	Gross Draft Rate (cfs)			Gross Draft Less Net Evaporation (cfs)			Gross Draft Less Net Evaporation (mgd)		
(Months)	Storage (cfs)	10	25	50	10	25	50	10	25	50
			Year =	2000	Volume * =	7018				
3	38.8	49.6	47.4	45.9	44.0	41.5	39.8	28.4	26.8	25.7
5	23.3	37.3	33.3	32.3	32.8	28.6	27.5	21.1	18.4	17.7
7	16.6	33.9	30.2	26.3	30.6	26.5	22.5	**19.8**[1]	**17.1**[1]	**14.5**[1]
9	12.9	51.9	34.2	25.9	49.5	31.6	23.1	31.9	20.4	14.9
			Year =	2010	Volume* =	6538				
3	36.1	46.9	44.7	43.2	41.3	38.8	37.1	26.7	25.1	24.0
5	21.7	35.7	31.7	30.7	31.2	27.0	25.9	20.1	17.4	16.7
7	15.5	32.8	29.1	25.2	29.5	25.4	21.3	**19.0**[1]	**16.4**[1]	**13.8**[1]
9	12.0	51.0	33.3	25.0	48.6	30.7	22.3	31.4	19.8	14.4
			Year =	2020	Volume*	6130				
3	33.7	44.5	42.3	40.8	38.9	36.4	34.7	25.1	23.5	22.4
5	20.2	34.2	30.2	29.2	29.7	25.5	24.4	19.2	16.5	15.8
7	14.5	31.8	28.1	24.2	28.5	24.4	20.3	**18.4**[1]	**15.7**[1]	**13.1**[1]
9	11.2	50.2	32.5	24.2	47.8	29.9	21.5	30.8	19.3	13.8
			Year =	2030	Volume*	5713				
3	31.6	42.4	40.2	38.7	36.8	34.3	32.6	23.7	22.1	21.0
5	19.0	33.0	29.0	28.0	28.4	24.3	23.1	18.3	15.6	14.9
7	13.5	30.8	27.1	23.2	27.5	23.5	19.4	**17.8**[1]	**15.1**[1]	**12.5**[1]
9	10.5	49.5	31.8	23.5	47.1	29.2	20.7	30.4	18.8	13.4

*Estimated volume in this year accounting for continued situation.
[1] 7 months is the critical drought duration.

Based on the estimated drought yields from ISWS, and the projected average and maximum day demands discussed in Chapter 3, Lake Vermilion has more than sufficient storage to last through a 50 year drought on an average day basis (8-9 mgd demands). On a maximum day demand (12-13 mgd) basis, the yield of Lake Vermilion is expected to be approximately equal to the demand. This is especially true as time goes on toward the end of the ISWS projection period in 2030. In this case, the reservoir may not be able to sustain a prolonged drought under prolonged maximum day demands. Exhibit 4-1 illustrates these trends. To help avoid this situation, CIWC should have a demand reduction strategy in place should the need develop to lessen peak demands. This would include conservation efforts, lawn sprinkling bans, outdoor usage bans, etc., as well as a predetermined method of communication to the general public.

C. LAKE VERMILION QUALITY

Lake Vermilion raw water quality is somewhat variable due to the simple fact that it is a surface water supply. Factors such as weather and land use have a large impact on the water quality in the Lake at any given time. Table 4-3 lists the average values for several key raw water characteristics for 1994 through 1997.

TABLE 4-3
RAW WATER CHARACTERISTICS

PARAMETER	AVERAGE
Alkalinity (mg/l)	193
pH	8.15
Total Hardness (mg/l as $CaCO_3$)	264
Non-Carbonate Hardness (mg/l as $CaCO_3$)	71
Calcium Hardness (mg/l as $CaCO_3$)	155
Magnesium Hardness (mg/l as $CaCO_3$)	109
Turbidity (ntu)	11

CHAPTER 5

REGULATORY CONCERNS

A. INTRODUCTION

Drinking water quality in Illinois is administered by the Illinois Environmental Protection Agency (IEPA). They are responsible for locally enforcing the Federal laws governing drinking water including the Safe Drinking Water Act. This Act was reauthorized in 1996, and at that time, many significant changes were made to the existing legislation. Many of these changes provided for entirely new "rule packages" which are being finalized and enforced over the following several years. Some of these new issues, as well as existing regulatory issues impact CIWC and are discussed in this chapter.

B. EXISTING REGULATIONS

Regulations already in place, which are of concern to the CIWC include those dealing with nitrates and synthetic organic chemicals. Additionally, several categories of regulations have been recently finalized or are due out in the near future, which include turbidity, disinfection by-products, and filter backwash recycle to name a few. All of these will likely impact the future of this treatment plant, and they are discussed individually below.

1. Nitrates

Nitrates are a common compound associated with many uses. Nitrates found in the Lake Vermilion watershed are the result of agricultural runoff. A very large majority of the watershed is actively farmed, which therefore contributes significantly to the problem. Nitrates in water are regulated by the EPA due to their effects when ingested in large quantities. Nitrates have been linked to <u>methemoglobinemia</u> or blue baby syndrome, which is especially troublesome to small children, causing death in severe cases.

The EPA has set the maximum contaminant level for nitrates at 10 mg/l measured as N. Current treatment practices at the CIWC plant do not provide much, if any, treatment for removal of nitrates. Typically, raw water nitrate levels are below the 10 mg/l standard; however, at times of high rainfall, the raw water nitrate levels can become quite elevated and remain above 10 mg/l as N for relatively long periods. This is especially true for a period from early spring, prior to planting, until a robust crop is established in late June or early July. When this occurs, the Water Company is in violation of the maximum contaminant levels set by the EPA. Violations have occurred for periods of up to 186 days with levels as high as 15.6 mg/l. Although, these levels, in and of themselves are not harmful to the general population, they do pose a threat to babies and young children.

The Water Company entered letter of commitment agreement with the Illinois Environmental Protection Agency in 1992 to rectify this problem.

The nitrate levels in the raw water are heavily dependent on rainfall and season. A high correlation between rainfall and elevated nitrate levels exists especially in the period from April to late June or July. Typically, there is a 24 to 48 hour lag between the rain event and elevated nitrate levels during these months. This is shown in Exhibit 5-1.

Peak nitrate concentrations in the raw water are also highly correlated with peaking total solids constituents, which also is consistent with the correlation with rainfall events. This is shown in Exhibit 5-2.

History indicates that the nitrate levels within the watershed will continue to be elevated for certain periods of the year. Therefore, long term treatment capabilities will be required to address the problem.

Future regulations on nitrates are not likely to change significantly.